AC 2012-3705: INTERDISCIPLINARY TEAMS THROUGH TWO COMPANION COURSES ON INFRASTRUCTURE

Dr. Matthew W. Roberts P.E., University of Wisconsin, Platteville

Matthew Roberts is an Associate Professor in the Department of Civil and Environmental Engineering. He earned his B.S. in civil engineering from Brigham Young University in 1993, then spent four years in the U.S. Air Force as a civil engineering officer. He received his Ph.D. from Texas A&M University in 2002 and has been teaching structural engineering topics at the University of Wisconsin, Platteville since then.

Dr. Michael K. Thompson, University of Wisconsin, Platteville

M. Keith Thompson is an Associate Professor at UW, Platteville. In addition to teaching Introduction to Infrastructure and Infrastructure and Society, he teaches a variety of courses in structural analysis and design. He professional background is in reinforced concrete behavior and design, but he has a research interest in engineering education, student retention, and best advising practices.

Dr. Philip J. Parker P.E., University of Wisconsin, Platteville
Prof. Barb A. Barnet, University of Wisconsin, Platteville

Barb Barnet has a Ph.D. in statistics from Iowa State University. She is currently Chair of the Mathematics Department at UW, Platteville.

Interdisciplinary Teams through Two Companion Courses on Infrastructure

Abstract

One of the program outcome criteria for ABET accreditation is that students demonstrate "an ability to function on multidisciplinary teams" (Criterion 3(d)).* An innovative way to meet this criterion was piloted at the University of Wisconsin—Platteville in the 2011 Fall Semester by the authors. During that semester, we taught two infrastructure-related courses. The first course, called "Introduction to Infrastructure Engineering" (I2I), was taken by civil and environmental engineering students. The second course, "Infrastructure and Society" (I&S), was offered as a social science course that fulfils the general education requirements of the university and was taken by non-civil engineering students from a variety of disciplines. Students from both courses worked together in interdisciplinary teams over the course of the semester to assess five different infrastructure components.

Initial assessment results with respect to the effectiveness of the interdisciplinary teams were disappointing. Student peer evaluations indicated that the students in the I&S course were not engaged in the teaming experience. In this paper we present the assessment results, discuss reasons for the lack of engagement and propose improvements to the courses to enhance the learning experience for I&S students so they will be more fully engaged as interdisciplinary team members.

Introduction

In the Fall Semester of 2011, two infrastructure-related courses were piloted at the University of Wisconsin—Platteville. The courses are:

- **Introduction to Infrastructure Engineering (I2I)** – A two-credit course intended for sophomore civil and environmental engineering students. Sixteen students were enrolled in the class, which was offered as a technical elective.
- **Infrastructure and Society (I&S)** – A three-credit social science course intended for any student not majoring in civil and environmental engineering. Civil and environmental students are discouraged from taking the course because some of the content mirrors what is taught in I2I and our goal is to have students outside the major take part in multidisciplinary teams. Nine students were enrolled in this course.

More details on these courses are given in the "Background" section below.

One of the major goals in offering the courses was to foster interdisciplinary teams between the students in the two courses. Accordingly, eight student groups were set up with each group consisting of two members of the I2I course and at least one member of the I&S course. Over the

* The terms "multidisciplinary" and "interdisciplinary" are used interchangeably in this paper to describe teams comprised of members with diverse areas of expertise. The terms can connote different types of teaming experiences[1], but we do not distinguish between the two in this paper.

course of the semester, the students performed five different evaluations of infrastructure components (e.g., pavements, bridges, etc.). These evaluations were intended to be simplified exercises modeled after the infrastructure assessments from the American Society of Civil Engineer's *Report Card for America's Infrastructure*.[2]

Background

The development of the I2I and I&S courses is the culmination of many years of effort by the Department of Civil and Environmental Engineering at the University of Wisconsin—Platteville. In 2005, five faculty members from the department were awarded an NSF Department Level Reform (DLR) planning grant (EEC 0530506). The work carried out under that grant included the planning of a civil engineering curriculum with an infrastructure theme. As part of the planning process for the new curriculum, the team of faculty members created a framework of the I2I class to be taken by sophomores. This class was intended to provide students with a better understanding of the challenges to be faced in improving, securing, and maintaining the national infrastructure. Part of the planned course included student evaluation of infrastructure components in local communities from direct observation.

In 2008, three faculty members from the department were awarded an NSF Course, Curriculum, and Laboratory Improvement (CCLI) grant (DUE 0837530) to create and teach the I2I course planned under the earlier DLR grant and to develop a general education infrastructure companion course for all students, which became the I&S course.

As completed under the grant funding, the I2I course is a two-credit course with four lectures devoted to introducing five sub-disciplines of civil engineering (transportation, construction, geotechnical, structural, and environmental). The remainder of the course covers broader themes such as the economic significance of infrastructure, infrastructure planning, teamwork, ethics, etc. Within this course, students work in teams to assess five infrastructure components from the surrounding campus and community. The I2I course has been piloted three times and will be taught for a fourth time in the spring 2012 semester. To date, 53 students have successfully completed the course and another 12 are enrolled for the Spring 2012 semester. The enrollment in the course will rise significantly to 100 students per year when it becomes a required course for the University of Wisconsin—Platteville civil and environmental engineering curricula in fall 2012. Assessment efforts have shown that the I2I course met its learning objectives.[3]

Also under the CCLI grant, the I&S course was developed to satisfy a social science elective under UW-Platteville's general education requirements. This course is a three-credit, non-technical course. Emphasis is placed on comprehension of social and economic impacts from infrastructure. While five sub-disciplines of civil engineering are explained within the course, more time is spent on such topics as environmental justice, sociological values and their role in infrastructure decisions, sustainability, planning and smart growth, historical development of cities, energy implications, and economic impacts from ill-maintained infrastructure among other topics. The students recruited to enroll in this course are not civil or environmental engineering majors. This course serves multiple purposes:

1. It can recruit undecided students into civil and environmental engineering;
2. It serves as a forum to educate the broader public about infrastructure and its importance for society; and

3. It provides a mechanism to create multidisciplinary teams of engineering students (in I2I) and students from other disciplines (in I&S).

The most recent syllabi for the courses are included in the Appendix.

Multidisciplinary Teams

As mentioned previously, one of the goals in having the two courses (I2I and I&S) was to provide a means of constructing multidisciplinary teams. The intent was that the engineering students in I2I would have the technical expertise to evaluate infrastructure from an engineering perspective, while the students in I&S would be the non-technical experts that would help the group to assess infrastructure from a societal viewpoint. For example, one of the infrastructure assessment assignments was the inspection of a storm sewer inlet. As part of the assessment, the engineering students calculated the estimated peak flow rate entering the inlet using a simplified hydraulic analysis learned in class. They also calculated the pipe capacity using Manning's Equation.[4] As a way to involve the non-engineering students, a societal impact analysis was also required with the inlet report. The students were given the following instructions.

> "If improvements are necessary for the system, one way to fund such improvements is to assess a fee for those people served by this section of the system (e.g., the people living within or who have businesses within the watershed area). Generally the magnitude of that fee is based on the amount of impermeable surface contained on their property. What would be the social impacts of such a fee? Comment on this with regard to the income levels of the people who live within the watershed or the way in which such a fee might be passed down through the costs of any businesses within that watershed."

We had high hopes for a meaningful interdisciplinary teamwork experience by the students in the two classes. Unfortunately, the actual implementation of the plan did not meet our expectations. On several occasions, engineering students in the I2I course complained that group members from the I&S course were unresponsive to requests for help in completing the assignments. Besides these anecdotal observations, data from our use of the Comprehensive Assessment of Team Member Effectiveness (CATME) instrument indicated that the multidisciplinary aspect of the teams did not function as we had hoped.

Assessment using the CATME Instrument

The CATME instrument provides peer assessment of individual performance for students in teams.[5] It rates students' performance in five categories:

1. Contributing to the team's work
2. Interacting with teammates
3. Keeping the team on track
4. Expecting quality
5. Having relevant knowledge skills and abilities

Each category is rated using a behaviorally anchored rating scale, meaning that rather than having students rate each other with a number or a Likert scale, a rating system is used that describes appropriate (or inappropriate) behaviors. When completing the instrument, the students choose which behavioral attributes apply to their team members and to themselves.[6] Figure 1 is an example of how the instrument works in assessing the first performance category ("Contributing to the team's work"). Each team member selects the behavioral attributes he or she feels best apply to team members and to himself or herself. A similar method is used to assess the other four CATME categories.

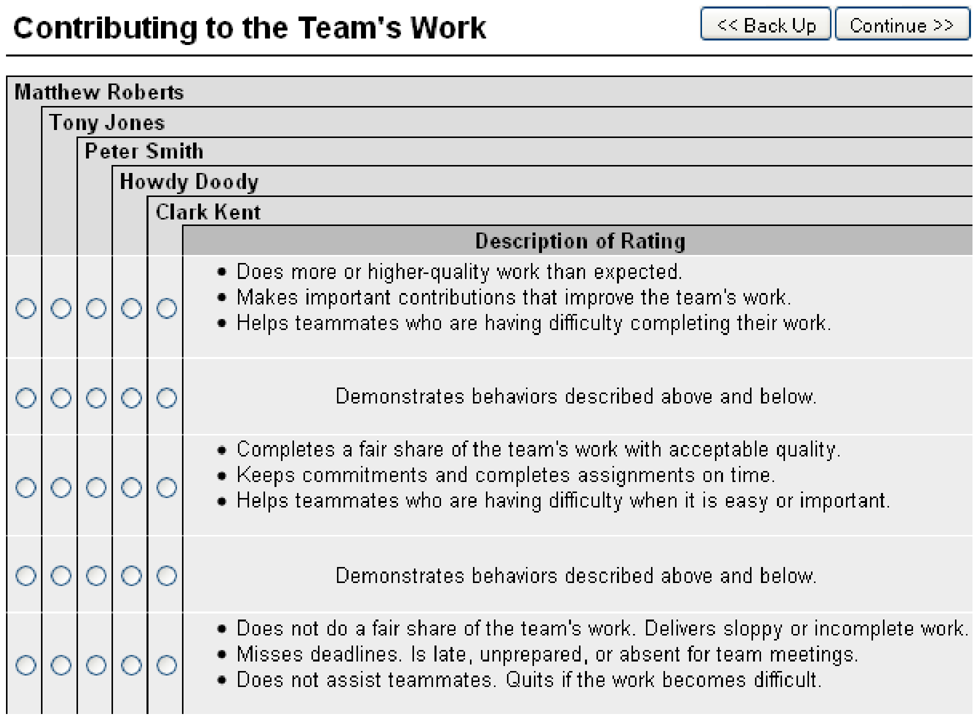

Figure 1 - The CATME instrument rating to assess "Contributing to the Team's Work"

To assess the effectiveness of the teams for this present study, we focus on the first ("Contributing to the team's work") and last ("Having relevant knowledge skills and abilities") categories of the CATME instrument. We consider the first category to determine in general how well the work was distributed among team members. The last category is considered to determine to what extent the teams functioned in an interdisciplinary manner.

While CATME is a behaviorally anchored rating scale, the results presented here have been converted to a numeric score. Attributes identified with unsatisfactory performance (e.g., "Does not do a fair share of the team's work" in Figure 1) receive a score of 1 up to a score of 5 for the most desirable attributes ("Does more or higher quality work than expected" in Figure 1).

In presenting the data from the CATME instrument, we will compare the engineering students' ratings of the non-engineers (in the I&S course) with the engineering students' ratings of themselves and the other engineering students on their team. We will not consider the CATME ratings done by the non-engineers. The reason we do not use the non-engineers ratings is that, with only one (and possibly two) exception(s), the non-engineers made no effort to distinguish performance levels between team members. Of the eight non-engineers (out of nine enrolled) who completed the survey, six gave identical scores to every team member for every one of the five CATME categories ("Contributing to the team's work," "Interacting with teammates," etc.) and one had only a single rating that varied. That left only one non-engineering student who responded in a way that could help in drawing meaningful comparisons. By contrast, of the 15 engineering students who took the CATME survey, only one gave every team member the same score for every category.

The results from the CATME survey for "Contributing to the Team's Work" are shown in Figure 2**.** In only one group (#5) did the engineers feel that all members of the team contributed equally to the work of the team. Two groups (#7 and #8) had a very large discrepancy between the perceived contributions of the engineers and non-engineers. In the rest of the groups, the difference in perceived effort was smaller, but consistently the engineers felt that the non-engineers did less work on the project.

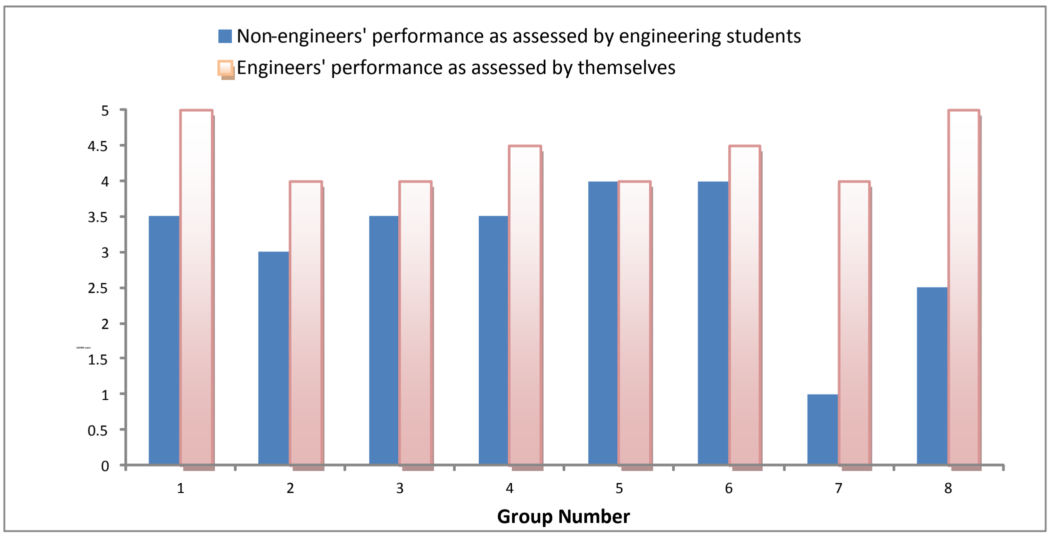

Figure 2 - CATME survey results for "Contributing to the Team's Work"

In order to assess the success of the course in providing a meaningful multidisciplinary experience, we consider the CATME results for the "Having Related Knowledge, Skills, and Abilities" category. The instrument for this category is shown in Figure 3 and the comparisons of non-engineers with engineers are shown in Figure 4**.** Again, the engineers consistently perceived themselves as better able to provide multidisciplinary expertise than the non-engineers. However, since a score of 3 corresponds to an acceptable level of multidisciplinary experience (one of the behaviors is described as "demonstrates sufficient knowledge, skills, and abilities to contribute to the team's work") we feel there was some worthwhile multidisciplinary benefit to the students in the courses because 6 of the 8 teams had a score of 3 or more for both the engineers and non-engineers.

Focus Group Observations

To gain further insight into the group dynamics in the I2I and I&S student teams, a focus group was conducted. Every student from both classes was invited to participate. None of the students from the I&S class responded, so only students from the I2I class participated in the focus group.

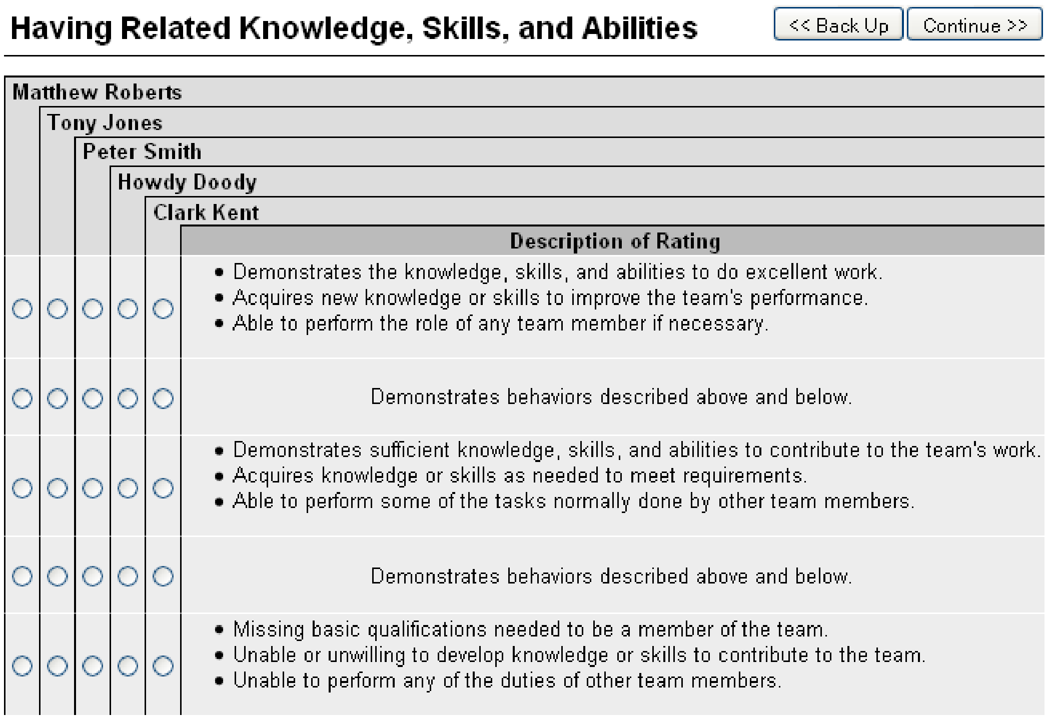

Figure 3 - The CATME instrument rating to assess "Having Related Knowledge, Skills, and Abilities"

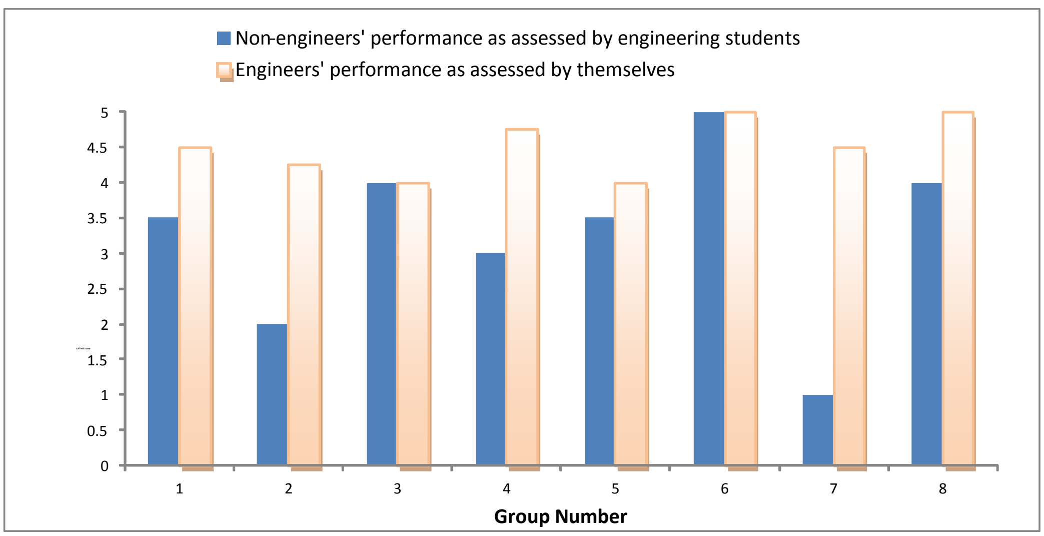

Figure 4 - CATME survey results for "Having Related Knowledge, Skills, and Abilities"

The focus group results provided further proof that our attempts at providing a multidisciplinary experience fell short. There were several comments such as, "We just got together once at the start, assigned tasks and didn't meet again," and "We segregated ourselves because we decided which tasks each class would do – just did them and did not meet." One student, when asked "What went well with the teamwork portion", responded "It was beneficial to have members from other classes as it was easier to delegate tasks." Such comments, while unsurprising to anyone who has conducted group projects in a class, indicate the typical "divide-and-conquer" approach, while we were hoping more for what has been described as "a dynamic, integrative mode of continuous learning and exchanges of ideas and information."[1]

Lessons Learned

Significantly, while much has been published on implementing multidisciplinary teams, there seems to be a paucity of published work on challenges, such as the ones we faced, in implementing multidisciplinary experiences. Richter[7] found that there were 624 citations for "multidisciplinary" papers at ASEE annual conferences between 2003 and 2006. A focused review found 86 papers presented on multidisciplinary teams at the 2007 ASEE annual conference. However, in reviewing the papers, Richter found they "[lacked] discussion on the challenges of teaching interdisciplinary courses and the skills faculty need to overcome these challenges." Furthermore, Richter specifically lists "interdisciplinary courses for early curriculum (freshman, sophomore)" and "horizontal integration with non-engineering disciplines" (two of the issues we faced) as challenges faced in multidisciplinary environments for which limited information is to be found in the literature.[7]

We believe there are three main reasons that the multidisciplinary teams did not function at the level we had envisioned. First, there is not equal inducement to both sets of students, since one group is approaching this course as a general education class and the other group is approaching it as a class in their major. Consequently, this creates a difference in attitude and hence perceived importance for these projects. There are very different incentives for each group of students. The difference in perceived importance was also reflected in the CATME survey results. The non-engineering students in I&S appear to have taken the survey less seriously then their teammates in the I2I course.

The second reason we feel that the multidisciplinary teams did not perform as well as we had hoped is that the two groups of students had not developed equivalent levels of work ethic at the time they took the course. The students in I2I had been through a "filter" of intensive courses including (for many of them): some lower level general engineering classes, at least Calculus I (or higher), some intensive natural science courses, and the entire English composition series of courses. Finishing this combination of courses requires positive affective behavior such as regular class attendance and dedication to putting high-quality work into assignments. In contrast, there was no such filtering process for many of the I&S students, who were still at the freshman or early sophomore level or enrolled in less intensive majors. The difference in the engineers' academic maturity compared to the non-engineers can be seen in Table 1, which shows the number of students in each academic class. As shown in Table 1, 15 out of 16 students in the I2I course were sophomores or juniors, compared to 5 out of 9 students in the I&S course.

The third reason was related to course management. The assignments for the multidisciplinary infrastructure assessments were distributed and explained in both courses, but only collected in the engineering version of the course. This may have de-emphasized the relevance of the assignments in the non-engineering version of the course. Furthermore, there was not enough threat provided by the grade weight given to the assessment projects. Students could achieve a passing (albeit low) grade in the non-engineering version of the course by focusing effort on other assignments and selecting to opt out from putting in effort on the multidisciplinary ones. This relates back to the first point regarding inducements but also points out a necessary component of true multidisciplinary projects in professional life, which is that all parties will come together having strong incentives for participation. Multidisciplinary projects created in the academic environment cannot take this component for granted, and if the incentive is not there inherently, it must be artificially enforced via strong grade risk for failure to participate.

Table 1 - The number of non-engineers and engineers by academic class

Academic Class	Non-engineers (I&S)	Engineers (I2I)
Freshman	4	1
Sophomore	2	10
Junior	3	5
Senior	0	0

Future Directions

The difficulties we faced may make the current implementation of the I2I and I&S courses as a means for creating multidisciplinary teams unworkable. Ideally, multidisciplinary teams should pair students from different disciplines who are at equal levels of academic preparation within their fields, who have equal motivation to successfully complete projects, and who have different, complementary skill sets that they can bring to the project.

The I&S course will be offered for the second time in the 2012 spring semester and we hope to improve the multidisciplinary experience. We intend to improve the experience by making two changes in management of the multidisciplinary projects: (1) collection of reports will alternate between the two courses, thus emphasizing the collaborative nature of the courses, and (2) minimum participation on assessments will be made mandatory for passing the course regardless of performance on other assignments.

Long term, we plan to add more instruction to the students in both classes on how to function effectively on a team. In fall 2012, the I2I course will be expanded to 3 credits (from the current 2), which will allow for additional teamwork content to be added. We anticipate using activities between the two classes that foster better interdisciplinary thinking.[8] In addition, existing teamwork modules will be used to better prepare our students to function on project team.[9] Lastly, rather than assuming that putting students from diverse backgrounds together will automatically lead to true multidisciplinary work, specific learning outcomes relevant to multidisciplinary teamwork will be added to the course.[10]

Acknowledgements

The authors wish to thank the anonymous reviewers for their thoughtful suggestions on how to improve the paper.

This material is based upon work supported by the National Science Foundation under Grant No. 0837530 (CCLI). Any opinions, findings, and conclusions or recommendations expressed in this

material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

1. Richter, David M and Paretti, Marie C. Identifying Barriers to and Outcomes of Interdisciplinarity in the Engineering Classroom. *European Journal of Engineering Education.* 2009, Vol. 34, 1, pp. 29-45.

2. American Society of Civil Engineers. Home. *Report Card for America's Infrastructure.* [Online] 2009. http://www.infrastructurereportcard.org/.

3. Roberts, Matthew W, Parker, P. J., Thompson, M. K., and Barnet, B. A. Development of an Introduction to Infrastructure Course. *Proceedings of the 2011 ASEE Annual Conference.* 2011. CD-ROM.

4. Ferguson, Bruce K. *Introduction to Stormwater: Concept, Purpose, Design.* New York : John Wiley & Sons, 1998.

5. Roberts, Matthew W. Using CATME to Create Student Teams and to Evaluate Team-Member Effectiveness. *Proceedings of the 2008 ASEE North Midwest Sectional Conference.* 2008. CD-ROM.

6. Ohland, Matthew W., Loughry, M. L., Carter, R. L., Bullard, L. G., Felder, R. M., Finelli, C. J., Layton, R. A., and Schmucker, D. G.. Developing a Peer Evaluation Instrument that is Simple, Reliable, and Valid. *Proceedings of the 2005 ASEE Annual Conference.* 2005. CD ROM.

7. Richter, David M. A Case Study of Pedagogy in an Interdisciplinary Green Engineering Course. Virginia Polytechnic Institute and State University : Master's Thesis, 2008.

8. Richter, David M, Paretti, Marie C and McNair, Lisa D. Teaching Interdisciplinary Collaboration: Learning Barriers and Classroom Strategies. *Proceedings of the 2009 ASEE Southeast Section Conference.* 2009.

9. Seat, Elain and Lord, Susan M. Enabling Effective Engineering Teams: A Program for Teaching Interaction Skills. *Journal of Engineering Education.* 1999, Vol. 88, 4, pp. 385-390.

10. Borrego, Maura, Newswander, Lynita and McNair, Lisa D. Special Session - Applying Theories of Interdisciplinary Collaboration in Research and Teaching Practice. *Proceedings of the 37th ASEE/IEEE Frontiers in Education Conference.* 2007.

Appendix: Syllabi for the I2I and I&S courses.

CEE 4980 – Introduction to Infrastructure Engineering – Fall 2011

General Information

MW 2:00–2:52 AM; 122 Ottensman Hall
Final Exam: 3:00–4:52 PM, Monday, December 19, 2011

Instructor

Dr. Matthew W. Roberts; 177 Ottensman Hall; 342–1535
robermat@uwplatt.edu; http://www.drroberts.org/

	Mon	Tue	Wed	Thur	Fri
8:00	CEE 4250	research	CEE 4250		CEE 4250
9:00		research			
10:00		research			
11:00		research			
12:00	CEE 3100		CEE 3100		CEE 3100
1:00				*office*	
2:00	CEE 4980	*office*	CEE 4980	CEE 3100	*office*
3:00	*office*	*office*	*office*	CEE 3100	
4:00	*office*	*office*	*office*	*office*	

Objectives

After taking this class, students should be able to:

1. Accurately describe the current condition of the nation's infrastructure.
2. Explain why functioning infrastructure is important for the nation's economy, security, and general welfare of the public.
3. Explain how professional engineers from the different civil engineering emphasis areas work with each other on various infrastructure problems.
4. Explain the variety of tasks civil engineers engage in to keep infrastructure functioning (planning, monitoring, inspection, etc.)
5. Explain how infrastructure decisions are influenced by a variety of engineering concerns (risk, constructability, performance criteria, etc.) and nonengineering concerns (such as politics, social priorities, etc.).
6. Develop simple plans for assessment of local infrastructure.

Grading

Assignment Weighting

2 Exams	30 %
Homework	10 %
Infrastructure Assessment Reports	45 %
Final Exam	15 %

Grading Scale

90–92 / 93–100	A- / A
80–82 / 83–86 / 87–89	B- / B / B+
70–72 / 73–76 / 77–79	C- / C / C+
60–66 / 67–69	D / D+
< 60	F

The percentages in the grading scale above may be lowered depending on our overall success this semester.

Tentative Schedule

Date	Reading	Topic
7 Sep		Lesson 1: Course Introduction
12 Sep		Lesson 2: Introduction to Infrastructure and ASCE Report Card
14 Sep		Lesson 3: Walking field trip
19 Sep		Lesson 4: Teamwork and Safety
21 Sep		Lesson 5: Transportation 1
26 Sep		Lesson 6: Transportation 2
28 Sep		Lesson 7: Transportation 3

3 Oct	Lesson 8: Transportation 4
5 Oct	Lesson 9: Construction 1
10 Oct	Lesson 10: Construction 2
12 Oct	**Exam #1 - Lessons 1–8**
17 Oct	Lesson 11: Construction 3
19 Oct	Lesson 12: Construction 4
24 Oct	Lesson 13: Public Financing and Economic Impacts
26 Oct	Lesson 14: Current Topic in Infrastructure
31 Oct	Lesson 15: Environmental 1
2 Nov	Lesson 16: Environmental 2
7 Nov	Lesson 17: Environmental 3
9 Nov	Lesson 18: Environmental 4
14 Nov	Lesson 19: Planning and Sustainability
16 Nov	**Exam #2 - Lessons 9–18**
21 Nov	Lesson 20: Structures 1
23 Nov	Lesson 21: Structures 2
28 Nov	Lesson 22: Structures 3
30 Nov	Lesson 23: Licensure and Ethics
5 Dec	Lesson 24: Geotechnical 1
7 Dec	Lesson 25: Geotechnical 2
12 Dec	Lesson 26: Geotechnical 3
14 Dec	Lesson 27: Wrap up

Notes

1. **Exams must be taken as scheduled.** Any absence not excused in advance will result in a zero for that exam. Examinations will be closed-book and closed-notes. You will be given a summary sheet to use on the exam that will include important equations. Depending on the coverage of the exam, code books may be allowed—I will let you know. If you feel an answer on an exam is unreasonable but cannot see the error (or do not have time to correct it) indicate your concern with an explanation of why the answer does not seem right.

2. Homework will not be accepted after the grader has picked up the assignment. There is usually not a set time when the grader will pick up the homework, so your best bet is to turn in the assignment during class. Please *do not* turn in homework once the lecture has started—wait until after class. Proper (full-participation) use of study groups for homework is encouraged (and may be required on some assignments). Improper (copying other people's work) use of study groups is a violation of engineering ethics. If you experience difficulty, don't waste time trying again and again. Instead, come to me for help with your basic approach. Of course, do not leave your homework until the last day.

3. **Cheating of any sort will not be tolerated.** As an engineer, your signature means that you have done the calculations and stand behind the results. If you collaborate with other students when completing homework assignments (highly encouraged) then note the names of those you worked with on the front of your homework.

4. **Desire2Learn** will be used to record your scores from homework, projects, and exams. `http://d2l.uwplatt.edu/`

5. If you need an accommodation due to a disability, please make an appointment to see me during office hours. A VISA from *Services for Students with Disabilities* authorizing your accommodations will be needed. For more information, see `http://www.uwplatt.edu/disability/`.

6. Please phone for help on assignments only as a last resort. **It is very difficult to understand your problem without seeing your work.** Providing help by e-mail is also difficult. The easiest way for me to provide assistance is to see your work first-hand during office hours. If you cannot make office hours, please email or call to make an appointment so I can be sure to be in my office when you stop by. Getting help on homework works best when you start your assignments early and do not leave matters until the last minute.

7. All **class correspondence** sent by me will be to your UWP e-mail address. I will not use non-UWP account addresses. You are responsible for periodically checking your UWP

account or having the mail from your UWP account forwarded to the e-mail address of your preference.

8. Seek help from me when you first encounter difficulty. Don't wait until you are behind to seek help. I am eager to help you in your desire to master the material of this course.
9. **Religious accommodations** will be granted for students who wish to observe religious events. You are responsible for letting me know within the first two weeks of class any accommodations you require. *You will still be responsible for the assigned work*, but you will be allowed a due date that does not conflict with your religious needs
10. **Veterans and reserve duty military personnel** with special circumstances are welcome and encouraged to communicate these in advance (if possible) to me. I am happy to work with you to ensure that your service will not conflict with your academic goals.

Expectations on Homework and Exams

Read the Directions - Many mistakes on homework and exams are made because students fail to read the instructions. This can be particularly detrimental on exams if unnecessary work is performed that wastes valuable time.

Work Symbolically - It is often preferable to develop solutions in terms of symbols. Reduce developed formulas as much as possible. Unless otherwise required, a numeric answer is acceptable on homework or exams.

Draw Diagrams - Diagrams should be drawn well (particularly on the homework) and should be reasonably close to scale.

Solve the Problem Clearly - Your solutions on homework and exams should flow logically and should be easy to follow. Indicate the basis for any new equations. Number all equations that are referred to by subsequent statements. Ask yourself, "Would I be happy to pay for the quality of work that I am producing?" On exams, make sure that any extra sheets you use are attached in order so that the exam can be graded without need to skip pages or turn to previous pages.

Clearly Mark your Answers - Answers should be easy to find and interpret. If you have multiple answers they must be summarized in a "results table" at the end of the problem.

Use Units - All your calculations should include units and the units on the final answer should be correct. Up to 5 points can be deducted on exams for consistently neglecting units or for incorrect units. Do not proceed with an answer if the units are obviously inconsistent.

Ask yourself: Is this answer reasonable? - If your answer does not seem reasonable and you don't have time to find your error (for example, on an exam), explain that the answer is not reasonable as well as a short explanation why you feel that way. Unreasonable answers that are not commented upon will lose points on exams.

Simultaneous Equations on Exams - You should be able to solve three simultaneous equations on exams.

CE 2010 – Infrastructure and Society
Schedule and Policies (Fall 2011)

Lectures MWF 2:00 – 2:52 PM; 140 Ottensman Hall

Instructors Dr. M. Keith Thompson; 178 Ottensman Hall
e-mail: thompsmi@uwplatt.edu

	Mon	Tues	Wed	Thurs	Fri
8 AM	CE 3150-01		CE 3150-01		CE 3150-01
9 AM	Office	Office	Office	Office	Office
10 AM	Office	Office	Office	Office	Office
11 AM	CE 3150-02	Office	CE 3150-02	Office	CE 3150-02
12 PM					
1 PM					
2 PM	CE 2010		CE 2010		CE 2010
3 PM					
4 PM					

Text Required readings will be posted on D2L in PDF format. Among the readings will be selected chapters from:

Penn, M.R. and Parker, P.J. *Introduction to Infrastructure Engineering: Civil Engineering, Environmental Engineering, and the Built Environment*

Objectives Infrastructure refers to the built environment, and includes things we see (roads, bridges, airports) and things hidden from view (building foundations, water distribution systems, wastewater collection systems). The US infrastructure is exceeding its design capacity and is rapidly deteriorating. It is imperative that the US has an effective infrastructure, as the quality of infrastructure directly affects the economy, the environment, national security, and ultimately all aspects of society.

We cannot fix the current infrastructure crisis using the same type of thinking that has created the problem. One manner of ensuring "different thinking" about infrastructure is to ensure that more non-engineers are involved in many of the decisions related to infrastructure. As such, these non-engineers must be broadly educated and knowledgeable about infrastructure. Additionally, many of the solutions to infrastructure problems require expertise from economists, sociologists, and legislators. These people are most able to help if they understand how it works.

From a more pragmatic viewpoint, everyone should be educated about the infrastructure as the U.S. has some difficult choices to make in coming years. We have been neglecting the infrastructure for a long time and to bring it back to the level it needs to be will mean sacrifices in other areas. U.S. citizens need to be informed about the infrastructure and its impact in order to wisely choose leaders who will be making funding decisions.

Thus, this course will help students understand how infrastructure works, but more importantly, how the infrastructure affects many aspects of human society. Students will synthesize concepts from many areas of social science using infrastructure as a focal point.

Specifically, at the end of this course, students will be able to:
1. Describe the functions and purposes of the civil infrastructure.
2. Explain the interactions between the built environment and the natural environment.

3. Describe the social, political, economic, ethical, and environmental considerations involved in infrastructure analysis and design.
4. Create basic social impact assessment reports for local infrastructure.

Grading

Exams and Quizzes	50%
Papers and Homework	50%

Final Averages:

≥ 90%	A
80 – 90%	B
70 – 80%	C
60 – 70%	D
< 60%	F

The grade ranges listed above are subject to adjustment based on the instructor's judgment. The +/- scale will also be utilized for students near the boundaries between grades.

Academic Misconduct

Instances of academic misconduct will be dealt with following the policies of UWS 14. Plagiarism, copying (beyond the collaboration specified in assignment instructions), and cheating on exams will be documented and reported following UWS 14.06 requirements. This means that a formal report will be filed with the Department Head, Dean of the College, the Assistant Chancellor for Student Affairs, and the Vice Chancellor's Office. This would probably ruin your day. The university policies regarding academic misconduct can be found at:

http://www.uwplatt.edu/university/documents/student_policies/chapter14.html#procedures

Notes

- **Exams must be taken as scheduled.** Any absence not excused in advance will result in a zero for that exam.
- **Students with disabilities** should make an appointment with me to arrange special accommodations. A VISA from Services for Students with Disabilities authorizing your accommodations will be required.
- **Religious accommodations** will be granted for students who wish to observe religious events. You are responsible for letting me know within the first two weeks of class any dates that you will need time off. You will still be responsible for the assigned work, but you will be allowed a due date that does not conflict with your religious needs. UWS 22.03 lists polices regarding religious accommodation.
- **The prerequisite for this course is Math 15 (Intermediate Algebra). The co-requisite is English 1130 (Freshman Composition).** It will be necessary that you have basic math competency to comprehend some of the engineering methods discussed in class and you will need composition ability to successfully complete the required papers.
- **Office hours** are listed on page 1. Students are welcome to ask me questions at any other time if I am available. If additional times are needed, then I can be flexible and arrange something.

Tentative Schedule for Fall 2011

Day	Date	No.	Topic
M	Sept. 5		Labor Day - No Class
W	Sept. 7	1	Introduction / Recent infrastructure problems / Pretest • Brief presentation on China's National Expressway and the Great Beijing Traffic Jam
F	Sept. 9	2	What counts as infrastructure / ASCE Report Card on U.S. Infrastructure • River Road Pipe Break • I35 Bridge Collapse • CRS Report For Congress RL32631
M	Sept. 12	3	Introduction to civil engineering • General Presentation on Civil Engineering, Sub-disciplines, Etc.
W	Sept. 14	4	Walking tour of campus infrastructure (weather permitting)
F	Sept. 16	5	Historical perspective of infrastructure (brief cases illustrating a few key points) • Catal Huyek and Mesopotamia – the 1st cities and the beginnings of infrastructure (why do we have streets?) • Rome and Porto di Triano – the link between food and transportation infrastructure • Mexico City and water problems • London, the Big Stink and the importance of sanitation • Historical trends in city size and problems with population
M	Sept. 19	6	Safety and teamwork
W	Sept. 21	7	Transportation systems • Transportation modes • Problems dealt with by transportation engineers
F	Sept. 23	8	Road construction • Issues that affect route selection (environmental concerns, cost of land, historic preservation, displacement of people, constructability) • Austin, TX and I35 (segregation) • Hoover Dam Bypass (security) • Steps in constructing a highway – quick overview
M	Sept. 26	9	Signage, traffic control • Overview of traffic control devices (signs, signals, markings) • Purposes of traffic control • Various Examples – poor intersections - videos • Innovative traffic control ideas (continuous flow intersections, diverging diamond intersections) • The role of enculturization – children's toys and exposure to transportation concepts at early age
W	Sept. 28	10	Social and economic impacts of transportation systems • Location of Madrid, Spain and bankruptcy of the Spanish empire • Access to mass transit and safe pedestrian routes • Curitiba, Brazil (planning, mass transit)

F	Sept. 30	11	Social and economic impacts of transportation systems – safety and security issues
			• New York Subways (crime - 1970's and today)
			• Terrorists attacks on mass transit (Tokyo, Madrid, London)
			• Gender differences and sexual assault/harassment:
			  o Whole trip concept
			  o Female only subway cars (Japan, etc.)
			  o Harassmap.org (Cairo)
			• Control of the trip (psychological perspective) – cars vs pedestrian modes

M	Oct. 3	12	Planning • The Big Dig

			• Curitiba, Brazil vs Sao Paolo, Brazil • Zoning (Platteville example) • UWP comprehensive plan
W	Oct. 5	13	Financing Infrastructure • Mechanisms (taxes, borrowing, user fees) • Pros and cons of various mechanisms • Water fees and protests in Cochabamba, Bolivia 2000 • Energy Costs in California – market manipulation in 2000/2001 • Trends in public spending on infrastructure • The Federal Highway Bill and gas taxes • Budget for a small city (Platteville's budget)

F	Oct. 7	14	Overview of Construction
			• Size of global construction sector
			• Corruption in the global corruption sector
			• Consequences of corruption
			    o Sampoong Superstore
			    o EQ fatalities from building collapse
			• What do construction engineers do?
			• Common problems in the field

M	Oct. 10	15	Hoover Dam Bypass Case Study • Overview of the bridge construction • Staging of construction • Problems in the field • Anticipation of problems and planning ahead

W	Oct. 12	16	Materials - Environmental and Economic Costs
			• How is cement made?
			    o Significance of concrete as a construction material
			    o Production process
			    o CO_2 emissions
			    o Mercury emissions (Ash Grove Cement Plant, Durkee, Oregon)
			    o Energy costs
			• Concrete – other costs (formwork, rebar, labor)
			• Steel
			    o Production process
			    o Typical shapes
			    o U.S. availability of shapes
			• Concepts
			    o Embodied energy
			    o Design for deconstruction vs recycling

F	Oct. 14	17	Pavements / Pavement Ratings • Overview of pavement distress and joints • Walking tour from the front of Otts to the West entrance of the PSC
M	Oct. 17		No Class (returning from ACI convention)

W	Oct. 19	18	Sustainability 1
			• Definition of Sustainability
			• Distinguish sustainability from durability & resilience
			• Endangered resources (water and arable land discussed)
			• Life cycle assessment
			    o Definition
			    o Brief Example

F	Oct. 21		Fall Break – No Class
M	Oct. 24	19	Sustainability 2 • More in-depth life-cycle assessment • Holistic questions o Resilience – surviving disaster enhances sustainability

			o Collateral impacts on building performance (ex – steel and thermal bridging) o Aesthetics – people must want to keep the structure/infrastructure around for a long time o Long-term functionality – changes in occupancy o Design for deconstruction o Assumption of proper construction/maintenance • Footprint? – eco-footprint website example
W	Oct. 26	**20**	**Midterm**
F	Oct. 28	21	Value systems – sociological perspective
M	Oct. 31	22	Current Topic
W	Nov. 2	23	Value systems
F	Nov. 4	24	Introduction to environmental engineering
M	Nov. 7	25	Environmental infrastructure / issues (Onondaga Lake case study)
W	Nov. 9	26	Broad overview of environmental engineering: drinking water, waste water, etc.
F	Nov. 11	27	In-depth lecture on storm water control Environmental finished by this date!
M	Nov. 14	28	Land-development example (Lehigh Acres)
W	Nov. 16	29	Displacement, Neighborhood Cohesion
F	Nov. 18	30	Structural – Overview
M	Nov. 21	31	Structural – Bridges
W	Nov. 23	32	Structural – Bridge Inspection
F	Nov. 25		Thanksgiving Break
M	Nov. 28	33	Structural – Structures Case Study (structural failure) Structural finished by this date!
W	Nov. 30	34	Structures Case Studies – Access, Societal Impact, Threat Assessment.
F	Dec. 2	35	Environmental Justice – Overview
M	Dec. 5	36	Environmental Justice – Case Studies
W	Dec. 7	37	Geotechnical Engineering – Overview
F	Dec. 9	38	Geotechnical Engineering – Retaining Walls
M	Dec. 12	39	Geotechnical Engineering – Retaining Wall Case Studies Geotechnical finished by this date!
W	Dec. 14	40	Wrap Up
F	Dec. 16	41	Wrap Up
M	**Dec. 19**	**-**	**Final Exam 3:00 – 4:52 PM**